SOILutions

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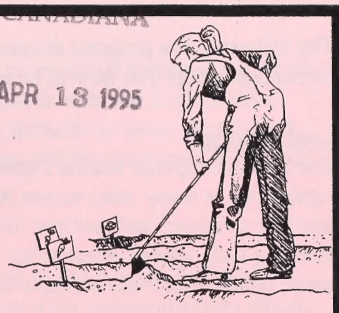

BUGS TAKE A BITE OUT OF WEEDS

Kim Stromme, Technician

Many people are interested in alternative weed control measures, such as biological control. Our most troublesome weeds are not native to Canada. They were introduced from Europe and have no native enemies. In Europe, these weeds do not become a problem because their indigenous enemies keep the plant population in check. Classical biological control involves introducing these foreign enemies (insects) and reuniting them with their host plant, to provide continual long term control.

The biological weed control program for Alberta is headed by Alec McClay, Weed Scientist, and his technician Rob Hughes of the Alberta Environmental Centre. Their work currently involves research with many problem weeds such as: leafy spurge, toadflax, bladder campion, Canada thistle, field bindweed, perennial sow thistle, scentless chamomile and common tansy. I work as a research technician with Dan Cole who is the Supervisor of Integrated Weed Control with the Agronomy Centre, Alberta Agriculture, Food and Rural Development. Our role is to extend information on biocontrol of weeds and provide some funding for the screening of insects. We also make field releases, monitor and redistribute the insects.

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MICRONUTRIENTS AND DIRECT SEEDING

Dr. Ieuan Evans, Research Agronomist

Direct seeding can have an effect on nitrogen requirements, plant diseases, weed dynamics and soil temperatures. Because of this, one might speculate that because of the higher levels of residue or organic matter, direct seeding may also effect micronutrient availability.

Some micronutrients are held tightly by organic matter and therefore may not be readily available for crop growth when organic matter levels are high. Cropping systems which result in the incorporation of large amounts of residue temporarily tie up these micronutrients. At present, however, there is no evidence that direct seeding either increases or decreases micronutrient deficiencies.

Most of the micronutrient research has been done under conventional tillage. But whether you are a direct seeder, a minimum tiller or a conventional tiller, there are some things about micronutrients you should know.

Micronutrients are essential for crop growth. They are called micronutrients because they are required for normal crop growth in much smaller amounts than macronutrients like N, P, K and S. Micronutrients include boron, copper, iron, manganese, molybdenum and zinc. They are usually present in varying levels in prairie soils.

Copper

Researchers at Alberta Agriculture, Food and Rural Development have studied copper availability and the

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This Issue:

Alberta
AGRICULTURE, FOOD AND RURAL DEVELOPMENT

Bugs - Continued

The following is a progress summary of the weeds and the biocontrol agents that we will be working with in 1995.

Leafy Spurge

The black dot spurge beetles (***Aphthona nigriscutis***) are established at many sites across Alberta. The beetles continue to spread and increase in numbers, significantly reducing leafy spurge infestations. The black dot flea beetle which effectively controls leafy spurge is currently available for redistribution.

Biocontrol clinics were held in 1991, '92 and '93 for provincial and municipal field staff. Training included: how and where to release the beetles and monitoring the beetles once the release was made. During the course of these clinics, there were enough beetles distributed for 230 releases across the province. In 1994, in Taber, we organized the first redistribution and training clinic held specifically for producers. Thank you to all who attended. Everyone showed a lot of interest and seemed very eager to try biological control for themselves. We will continue redistribution of the black dot spurge beetles getting them out to as many suitable sites as possible.

The black dot beetle is most effective on a high, dry south-facing slope or on a very well drained area.

Many releases of the brown dot spurge beetle (***Aphthona cyparissiae***) have also occurred. While some have established, we have not been as successful as Saskatchewan. There is some speculation on the type of site it requires.

The copper spurge beetle (***Aphthona flava***) has recovered from the cool summer conditions in 1993. We will continue to monitor all of the sites. More releases are planned for the root feeding flea beetle (***Aphthona lacertosa***), the stem mining fly (***Pegomya euphorbia***) and the defoliating moth (***Minoa murinata***).

Toadflax

We will be looking at the overwintering survival of a root boring moth (***Eteobalea serratella***), and a stem boring weevil (***Mecinus janthinus***). One of these species will be selected for further studies in toadflax infested alfalfa and barley plots in Edmonton and Lacombe.

Bladder Campion

The tortoise beetle (***Cassida azurea***) has established at most sites but has not yet shown any major effects on bladder campion.

Canada Thistle

Lema cyanella is a leaf feeding beetle, currently being studied for its ability to adapt to Alberta conditions.

Field Bindweed

Further releases of the gall mite ***(Aceria malherbae)*** will be made.

Scentless Chamomile

More releases are planned for the seed feeding weevil (***Apion hookeri***) which was recovered for a second year at the site in Sherwood Park.

Common Tansy

Practical research is being conducted that will determine the economic impact of common tansy in Alberta to support the feasibility of biological control.

For more information please contact Kim Stromme at (403) 427-2530

GONE FISHING - TERRY FOOTZ RETIRES

Scott Schaffert, Technician

After more than thirty-four years of service Terry Footz is retiring from Alberta Agriculture, Food and Rural Development. Terry has been the Pesticide Application Equipment Specialist for the Soil and Crop Management Branch. Terry began with Alberta Agriculture, Pest and Weed Control in 1961and was involved with weed control demonstration plots, forage seed collection and pest control training.

He started his sprayer clinics in 1973 and has conducted over 500 clinics from one end of the province to the other. Many Alberta producers, Agricultural Fieldmen, District Agriculturists and industry personnel have attended at least one of these events. We learned a lot from Terry. Many producers mixed herbicides with their bare hands, mouth-cleaned nozzles and sprayed with open-cab tractors without protective equipment. Worn or damaged nozzles and pumps were frequently used. Terry's clinics showed us safer and more cost efficient methods in plain English, before it was fashionable. Terry also kept on the cutting edge of new technologies. As new equipment became available he would test the new inventions to determine their usefulness. If a new nozzle didn't get the Footz stamp of approval it wasn't worth buying. As Pesticide Applicator Equipment Specialist Terry has taught us how to apply pesticides and what equipment to apply it with.

We will miss his expertise and sense of humor. The agricultural industry as a whole owes a debt of gratitude for his many years of quality service. We wish him every happiness in his retirement. Save some fish for us Terry!

A special farewell luncheon will be held at the Ellerslie Rugby Club on Friday, April 28, 1995. **For further information contact Lorraine at 427-7098.**

effects of copper deficiency on crop yields. They found copper availability may be a problem if the following characteristics are present:

* high soil organic matter content in mineral soil
* peat soil
* light, sandy soils
* heavy crop residues from the previous season
* heavy manure applications
* a crop sensitive to low levels of copper, like barley, wheat or flax
* high soil pH
* high levels of other micronutrients such as zinc, iron and molybdenum
* low available soil copper
* a herbicide that may interfere with copper metabolism in the crop
* high nitrogen and/or high phosphate levels

Any of these factors can cause minor to drastic reductions in crop yield and quality, especially in wheat and barley cultivars. A combination of several factors can cause total crop failure.

The total acreage of land affected by copper deficiency in Alberta cannot be accurately estimated. Soil types on which copper deficiency has been observed total at least 3 million acres. Soil samples should be taken to determine if copper deficiencies are responsible for poor yields. There are several copper fertilizers available in Alberta that can be used to overcome copper deficiency.

Other Micronutrients

Much less research has been done on the role of other icronutrients in crop production in Alberta.

Zinc deficiencies tend to occur on calcareous, high pH soils that are sandy or high in phosphorus. Some producers in southern Alberta add zinc to irrigated fields intended for bean production.

Manganese deficiencies are most common on organic soils and high pH mineral soils. Cereal crops are generally susceptible to manganese deficiency, but there are large differences among varieties. Often, manganese deficiency may be largely overcome by choosing resistant varieties.

Research specifically documenting response to added boron is limited. Cereal crops do not appear to respond to boron additions. Canola, pea and bean yields have on occasion declined by 10% to 20% due to boron toxicity after a 2 lb/ac application of seed row boron fertilizer.

Selenium is a micronutrient essential for livestock health. It is deficient in many Alberta soils but is sometimes overabundant or in toxic amounts in some pastureland. Although present in plants, selenium appears to play no role in metabolism.

More Information

Producers concerned about micronutrient deficiencies should have their soils tested for these nutrients. If low levels appear to be causing serious yield reductions, producers are encouraged to apply nutrients in test strips to see if micronutrient fertilizers will give economic yield increases.

For more information, refer to *Micronutrient Requirements of Crops in Alberta* (Agdex FS531-1) and *Copper Deficiencies in Cereal Crops* (Agdex FS532-2), available from a district office of Alberta Agriculture, Food and Rural Development.

POTENTIAL PROBLEMS WITH GRAZING TALL FESCUE

Lorraine Harrison, Plant Pathologist, Fairview

Tall fescue, ***Festuca arundinacea,*** shows promise as an alternative crop in regions of the province which grow grasses. In the Peace Region, several varieties have been grown since 1992. Tall fescue should not be confused with creeping red fescue, ***Festuca rubra***, which has been grown for many years.

Tall fescue is a perennial grass used for various turf purposes including erosion control and livestock feed. Variety trials at the Northern Research Centre in Beaverlodge show that tall fescue is a cool season grass well adapted to this region

However, growers should be aware of the toxic effects on livestock associated with grazing or feeding tall fescue grass. Since fescue toxicity is similar to ergot poisoning, animals consuming infected plants may become affected.

Endophyte infected tall fescue

Fescue toxicity is caused by a toxin produced by a fungus growing inside the plant. The fungi, called endophytic fungi; "Endo" (within) "phyte" (plant) means a fungus living within the plant.

The endophytic fungus is not a disease of tall fescue and there are no visual symptoms on the grass. A laboratory

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Fescue - Continued

analysis is needed to determine the presence of the fungus. It is only transmitted by seed. Once an infected stand is established, it will remain infected.

Problems associated with feeding endophyte infected tall fescue

- reduced feed intake - higher body temperatures
- lower weight gains - less time spent grazing
- rough hair coats - decreased milk production
- birth problems - gangrene of hooves, feet and ears

Several varieties of tall fescue grown in the Peace Region were tested for the endophytic fungi at the Fairview Regional Crops Lab in 1993 and 1994. The varieties tested were K31, Jaguar, Pengrazer, Peace and Mustang. All varieties had the endophytic fungi present. Mustang had the lowest level at 65%. All other varieties had levels of 90-100%.

If growers are interested in growing tall fescue, they should be aware of the effects of endophyte fungus on livestock and follow the strategies to minimize the detrimental effects.

Strategies to minimize endophyte effects:

1. When planting a new fescue field, use non-infected or varieties with low levels of endophyte. Ask the seed dealer for tags giving levels and details on the variety. Storing the seed for one year will decrease endophyte levels, however germination will also decrease.
2. Graze early in the spring. There is less endophyte in the plant.
3. The endophytic tall fescue can be diluted by using other feeds. It is recommended to plant a legume companion species with the tall fescue. Dilution with 50% other forage is effective in reducing the adverse effects on cattle. However, pregnant mares are extremely sensitive to endophytic tall fescue and should not graze or feed on hay with the endophyte.

WEED RESEARCH SYMPOSIUM

Camille Ducharme, Technician

New trends, topics and issues are popping up sooner than weeds in the spring. In response to this, the Agronomy Unit (formally the Soil and Crop Management Branch) in cooperation with the University of Alberta held a Weed Research Symposium to update everyone on the latest information.

Topics discussed included: herbicide carryover, integrated control of weeds, Blue Book update, Tolerance of Forage Crops to Herbicides Manual update, water quality effects on herbicide performance, pre-harvest Roundup and seed vigor, reduced herbicide rates, weed control in peas, herbicide resistance, purple loosestrife update and the status of herbicides in groundwater.

Speakers included:

Shaffeek Ali: AAFRD, Edmonton
Bob Blackshaw: Ag. Canada, Lethbridge
Lloyd Darwent: Ag. Canada, Beaverlodge
John O'Donovan: Ab. Environmental Centre, Vegreville
Ken Kirkland: Ag. Canada, Scott, Saskatchewan
Neil Harker: Ag. Canada, Lacombe
Bernie Hill: Ag. Canada, Lethbridge
Rick Holm: University of Saskatchewan, Saskatoon
Jim Moyer: Ag. Canada, Lethbridge
Scott Schaffert: AAFRD, Edmonton
Sarah Foster-Stubbs: 20/20 Seed Labs, Nisku

If you missed the Symposium and would still like to keep up with all the new weed research trends, topics and issues, a copy of the proceedings will be available. **For more information concerning the Symposium contact Camille Ducharme at 427-2530.** Don't be left out in the cold, get your copy today!

What Are Calories?

Calories are little units that measure how good a particular food tastes. Fudge, for example has a great many calories, whereas celery, which is not really a food at all but a member of the plywood family provided by Mother Nature so that we would have a way to get onion dip into our mouths at parties, has none.

Dave Barry, *Stay Fit & Healthy Until You're Dead (Rodale)*

WHO'S HANDLING YOUR CALL?

Scott Schaffert, Technician

With spraying season just around the corner, many people are calling into the Agronomy Unit for weed control information. Dan Cole, Supervisor of Integrated Weed Control, is on education leave completing his masters degree. This leaves Denise Maurice, Supervisor of Weed Research and Technology Development, with the assistance of Technicians, Kim Stromme, Camille Ducharme and Scott Schaffert to cope with the onslaught of incoming calls.

- Denise will handle her usual abundance of calls.
- Kim will provide answers to any biological weed control calls as well as general weed concerns. She is also writing facts sheets on cleavers, stork's-bill and mustards.
- Camille is organizing the Crops of Alberta and a weed seedling identification manual. Any questions in this regard should be directed to Camille.
- Scott will handle calls dealing with weed control in forage crops and Minor Use Registration. Scott has updated the Tolerance of Forage Crops to Herbicides Manual.

CLEAVERS RESEARCH

Kim Stromme, Technician

With the increase in canola acreage, occurrence and awareness of the noxious weeds, cleavers and false cleavers, have also increased. Both species occur in Alberta. Cleavers is native to the wooded habitat of Alberta but introduced into grain fields, while false cleavers was strictly introduced into Alberta. Of the two species, false cleavers is the more aggressive and adaptable to the prairie provinces. The characteristics of Cleavers and false Cleavers are so similar that the only sure way to identify the species is by doing a chromosome count. A study was initiated to determine the most prevalent cleavers species. We requested a sample of cleavers seeds from a number of seed cleaning plants throughout Alberta. The species of these seeds will be determined by growing the plants and doing chromosome counts. The response and cooperation from the seed cleaning plants was excellent and our thanks go out to them.

A factsheet on biology and control of false cleavers was officially released at the Weed Research Symposium March 29, 1995 at the U of A.

PLANT INDUSTRY DIVISION - CHANGING TO MEET THE NEEDS OF OUR CLIENTS

Plant Industry Division has taken the next step in moving forward with its own and the department's business plans. The Division is now made up of eight work units, lead by a division management team as follows:

Agroforestry Unit - Mr. Brendan Casement
Agronomy Unit - Mr. Dan Heaney
Cereals & Oilseeds Unit - Dr. Jim Helm
Diagnostic & Laboratory Unit - Mr. Jim Letal
Forage Unit - Mr. Bob Nelson
Horticulture & Apiculture Unit - Mr. Tom Krahn
New Crop Development Unit - Dr. Ron Howard
Pest Prevention Unit - Mr. Walter Yarish

Several of the locations of division research activities will change their focus and as such are renamed:

- the Alberta Special Crops and Horticultural Research Center is now **Crop Diversification Centre, South**
- the Alberta Tree Nursery and Horticulture Research Centre is now **Crop Diversification Centre, North**
- The Alberta Soils and Animal Nutrition Laboratory is now **Soil & Crop Diagnostic Centre**
- and the offices and laboratories of the Agronomy Unit is now **Agronomy Centre**

These centers together with the Field Crop Development Centre at Lacombe, division offices, and staff in Fairview, Lethbridge and Vermilion, provide for a diverse base from which to serve the industry.

It is suspected that under certain environmental conditions and with some farming practices, a winter annual form of cleavers can exist. We would be interested in hearing from anyone who has observed any overwintering behavior displayed by cleavers, especially with direct seeding.

For more information please contact Kim Stromme (Alberta Agriculture, Food and Rural Development at (403) 427-2530

BURNING CROP RESIDUES

Dr. Ieuan Evans, Research Agronomist

Residue burning has been a common practice on the prairies because it offers some short-term gains. However, frequent burning causes serious problems including reducing the soil's ability to produce crops.

Short -Term Gains

Burning residues can have some short-term benefits for the producer and the next crop:

Better Disease Control: Burning virtually eliminates disease-causing organisms that overwinter on crop residues (such as net blotch of barley or septoria of wheat). It is especially effective for disease control when growing barley after barley or wheat after wheat.

Faster Soil Warming: Without crop residues to reflect sunlight, soil warms faster in early spring allowing earlier seeding.

Easier Seeding: Crop residues can interfere with seeding. Burning allows seeding equipment to place seed at a more uniform depth. Burning also maintains a firm seed bed, which is particularly important for small-seeded crops like canola.

Mobilization of Nitrogen and Phosphate: Nitrogen and phosphate can be tied up by crop residues in the soil. The more residue, the more likely the tie-up. Burning releases the tied-up phosphate, but nitrogen is lost to the air by burning.

Increased Micronutrient Availability: Micronutrients, especially copper, can also be tied up by crop residues. This can significantly reduce yields on soil low in available copper. Burning may release the tied-up copper. (For more information, see the *Alberta Fertilizer Guide,* Agdex 541-1, from Alberta Agriculture, Food and Rural Development, and *Copper Fertilizer Requirements on Peat Soils,* Manitoba Agriculture Agdex 541).

Short-Term and Long-Term Pain

Residue burning has the following negative effects:
Nitrogen Loss: Nitrogen in crop residues is released to the atmosphere on burning. This can result in the loss of as much as 20 to 30 pounds per acre of nitrogen from a 50 bushel per acre wheat crop.
Organic Matter Loss: Soil organic matter provides many benefits including improved soil tilth, water-holding capacity and nutrient holding quality. Burning reduces these benefits.

More Evaporation: Bare soil loses much more water essential for optimum crop yields. This moisture loss is particularly critical during periods of unusually low precipitation in dry areas.

Less Snow Trapping: Fall burning destroys residues that can trap snow for spring soil moisture. Snow trapping can greatly improve crop yield and quality in dry areas in most years.

More Erosion: Bare soil lacks protection from wind and water erosion. Erosion removes the topsoil, the most productive part of the soil.

Other Hazarads: Burning crop residues can also cause fire hazards for buildings and woodlots and destruction of wildlife. Air pollution and traffic hazards due to smoke can cause serious problems for nearby residents.

Maintaining Productivity

Maintaining crop residues helps maintain or improve the soil's capability for sustained crop production. If residues are never burned, they will eventually release all the tied-up nutrients through normal decomposition. Over a few years, nutrient tie-up and release will reach a balance, when residue decomposition roughly equals input.

Burning of very heavy stands of unharvested cereal straw (after an early frost or flood) may be justified occasionally. However, annual burning is harmful to the soil's long-term productivity. Any disadvantages of not burning can be overcome through such practices as longer crop rotations, evenly spread crop residues and extra fertilizer in years with unusually high residue loads.

The first Dirt Capades

Dear Aggie

Dear AGGIE:

For the last 3 years I have been using Group 1 herbicides to control my wild oats. I want to set up a good herbicide rotation. Any suggestions?

I.N. Fested

Dear I.N. Fested

Good idea, by not rotating your herbicides you are setting your weeds up to develop resistances! A good herbicide group rotation is essential to minimize the development of resistant weeds. The number of herbicide resistant weeds and the area presently infested by them continues to increase. In 1989, seven sites were confirmed to have triallate (Avadex BW) resistant wild oats. By 1995, over 50 sites were confirmed with triallate resistant wild oats. Presently 4 weed species and four different herbicides are affected by resistance.

How to minimize the development of resistant weeds:

- Rotate herbicides
- Crop rotation
- Use herbicides only when needed
- Keep accurate application records
- Use tank mixes

To set up a good herbicide rotation, you have to know what herbicdes you can use for that crop and weed problem as well as what group each herbicide falls into. The 1995 Blue Book can help you choose the herbicide that best fits into the rotation. A previous SOILutions article, Vol. 2, No. 2, Summer 1991, written by our own Denise Maurice, Supervisor, Weed Research and Development, will also be of interest. 1995 Blue Books are available at a cost of $10.00 + GST from:

Publishing Branch
Alberta Agriculture, Food and Rural Development
7000 - 113 Street, Edmonton, AB., T6H 5T6

*****

Dear AGGIE:

Help! Is there anything I can do for control of Cleavers in Field Peas?

E.N. Tangled

Dear E.N.:

Yes. Pursuit has just been registered for field peas. The key to Cleavers control is to apply Pursuit before the 4 true leaf stage. Pursuit can be used until the peas are at the 6th trifoliate leaf stage.

Your letters are welcome. Please mail or fax to:
SOILutions
Alberta Agriculture, Food and Rural Development
905, 6909 - 116 Street
Edmonton, Alberta T6H 4P2
Phone 427-6361
Fax 427-1439

NUTRIENT DEFICIENCIES ABOUND...

Beth Hoar, Technologist

Interested in seeing what copper deficiency looks like in flax; what sulphur deficiency looks like in canola? Come on out to the greenhouse at the University of Alberta! A demonstration has been set up to show nutrient deficiency symptoms. Canola, flax, peas and wheat were seeded into soils which are deficient in nitrogen, phosphorus, potassium, sulphur, copper and boron. For each nutrient, a severely deficient and a moderately deficient soil has been used. This allows a comparison of plants with symptoms of varying severity with plants grown in nutrient sufficient soils.

In many cases, moderate deficiency symptoms are hard to diagnose, yet can cause a significant yield loss. Severe deficiency symptoms, though more readily recognizable, may have caused yield loss before they can be corrected (if they can be corrected). To confound the problem, deficiency symptoms may be confused with other symptoms caused by: herbicide damage, disease, insect damage and environmental stress. The vast number of possible causes of symptoms identifies the importance of being able to assess crop health at every stage of growth. See if you can identify these symptoms!

Call Beth Hoar or Joan Seath, AAFRD, at 427-2530 for a tour.

This demonstration, sponsored by Sherritt Inc., Westco, The Potash and Phosphate Institute and AAFRD, is ready for viewing from now until the end of April.

MEET THE SPECIALIST

Ieuan Rhys Evans
Research Agronomist
(Plant Pathologist)

Raised on a mixed livestock and vegetable farm in South West Wales. Graduated from University College of Wales Aberystwyth in 1963 with a B.Sc. degree in chemistry and agricultural botany. Graduated from University of Florida in 1969 with a Ph.D. in Plant Virology and Plant Nutrition. Thesis title "Comparative aphid and mechanical transmisibility of bean yellow mosaic virus isolates".

Faculty member, instructor, assistant professor, Department of Environmental Biology, University of Guelph, Ontario. Carbathiin (Vitavax) treatment of loose smut in wheat and barley.

Since joining Alberta Agriculture:

* Provincial plant disease diagnostician
* Provincial coordinator - diagnostics - Vegreville, Olds and Fairview.
* Alberta Environment Centre 1979-1981 Head, Plant Pathology Section.

Research Projects

* 1979 - Seed treatment of canola, presently registered treatments (1979).
* 1981 - Sclerotinia control with Benlate and Rovral - aerial application (Williams, Evans and Thomas).
* Herbicide injuries (Tordon/Hoegrass/Lontrel). Text - Herbicide action and injury with W. Yarish.
* Bacterial Ring Rot of Potatoes - Control Program
* Blackleg of Canola - Control Program
* 1976 - present - Copper nutrition (deficiency) in cereals - Westlock, Lacombe, etc. Letal, Carlyon, Bjorge, Piening, Penney, Solberg and Maurice.
* Numerous factsheets and published papers "Blue Book", "Green Book", Backyard Pest Management.

Married to Kathy at Gainesville, Florida on July 12, 1969 and have 3 daughters, Megan 23, Jennifer 21 and Meredith 19. Involved in Rugby and Horticulture as hobbies. Have raised millions of dollars for rugby (7 million dollars) and "installed", directed, landscaped or supervised 25 rugby fields in Alberta. Ellerslie Rugby Park (31 acres) is perhaps the best known site.

HERBICIDE MECHANISM OF ACTION TRAINING SESSION

Camille Ducharme, Technician

Herbicide use patterns in Alberta have changed in the last several years due to the introduction of new herbicides, tank mixes, crops and crop varieties. The movement away from tillage as a weed control method and emerging environmental issues have made understanding herbicides much more critical.

In response to the changing agriculture scene; Alberta Agriculture, Food and Rural Development, Agronomy Unit and the University of Alberta, Department of Agricultural, Food and Nutritional Science held a two day training session for professional advisers involved in agriculture. The intensive training session helped establish a better understanding of the herbicide mechanism of action. How herbicides work, their selectivity and behavior in plants and soil, were some of the topics discussed. The training session was held during the last week in March, concurrent with the Weed Research Symposium.

SOILutions is published three times a year by the Agronomy Centre, Alberta Agriculture, Food and Rural Development. Your comments on current contents, ideas and contributions for future articles are welcome. For further information phone, fax or write to:

SOILutions
Alberta Agriculture, Food and Rural Development
905, 6909 - 116 Street, Edmonton, Alberta, T6H 4P2

c/o Marilyn Touchette
Phone 427-6361, Fax 427-1439

or

c/o Joan Seath
Phone 427-2530, Fax 427-0133